African Journal of Agricultural Research Vol. 7(19), pp. 3007-3013, 19 May, 2012
Available online at http://www.academicjournals.org/AJAR
DOI: 10.5897/AJAR11.1379
ISSN 1991-637X 

*Full Length Research Paper*

# Nutritive evaluation and acceptability of two aquatic weeds (*Eichhornia crassipes* and *Acroceras zizanioides*) by West African dwarf goats

**Mako, A. A.*, Banjo, O. S. and Akinwande, V. O.**

Department of Agricultural Production and Management Sciences, Tai Solarin University of Education, Ijagun, PMB, 2118, Ijebu-Ode, Ogun State, Nigeria.

Accepted 9 May, 2012

**Aquatic weeds are plants which grow and reproduce in rivers, streams, brooks, swamps and dams without agronomic care. They have potentials as forage for ruminants. The chemical composition, forage acceptability, secondary metabolites and N- balance of *Eichhornia crassipes* (EC) and *Acroceras zizanioides* (AZ) were studied using West African Dwarf goats. The effect of rainy and dry seasons in EC was not noticed for dry matter, crude protein, ether extract, crude fibre and ash. Crude protein content was highest (14.40%) in the leaf but least (7.04%) in the stem and this was contrary for crude fibre. Fresh EC and AZ were richer in crude protein (11.80 and 23.60%) respectively, but lower in dry matter (7.70 and 18.72%) than the dried form. AZ contained more crude protein (23.6%) and was more preferred in the fresh and dried forms by goats than any of the presented form of EC. The two water weeds contained tannin, phenol and saponin at non-toxic levels. Dry matter intake (DMI) increased at 20 and 40% supplementation than grass alone, but decreased with 100% AZ. N-balance and N-retention by goats was positive in AZ composed forages, but negative for AZ alone. The results revealed that EC and AZ are potential sources of nutrients for ruminants.**

**Key words:** Aquatic plant, chemical composition, forage acceptability, secondary metabolites, nitrogen balance.

## INTRODUCTION

In many of the ruminant production systems in the developing world, natural grass pastures make the bulk of the feed. This is because ruminants are endowed with the ability to degrade and utilize forages with the help of rumen microbes. Babayemi (2007) reported that quality and seasonal nature of forages together with low intake and poor digestibility of forages by animals are major factors that contribute to low productivity by ruminant animals. Dietary protein intake, particularly of animal origin is low in the tropics. The conventional feedstuffs like cereals for farm animals are becoming impossible for large scale farmers due to soaring prices of such feeds.

Presently, in Nigeria and other developing countries, dietary protein consumption is 75% below FAO requirement (Erinoso et al., 1992; Oguntona and Akinyele, 2002). The FAO recommended a minimum of 35 g/head/day of animal protein for good health, but the actual average consumption in Nigeria is 4.5 g/head/day (Atsu, 2002). This is grossly inadequate and it implies that sustainability of ruminant livestock on grasses, herbaceous legumes, browse and multipurpose plants, crop residues, industrial and agro-industrial bye products becomes difficult. This has called, not only for better utilization of already known non conventional feed resources, but also for identification and introduction of new and lesser known plants, underutilized as fodder crop. They may be capable of growing without tillage and cultivation abundantly throughout the year with no agronomic care. *Eichhornia crassipes* and *Acroceras zizanioides* are important class of plants underutilized as

*Corresponding author. E-mail: jokemako2006@yahoo.com or Jokemako2006@gmail.com. Tel: 08057085436 or 08023292736.

fodder. Therefore, aquatic plants can be used as animal feed. There are many aquatic plants growing on Nigeria water ways that can serve as fodder for ruminants. *E. crassipes* and *A. zizanioides* are common aquatic plants found on Nigeria water ways.

*E. crassipes and A. zizanioides* are perennial aquatic herbs growing abundantly throughout the year in rivers, lakes, ponds and dams. They do not compete with other agriculturally useful vegetation for growing space and are of no dietary importance to man. During the dry season when most grasses, legumes and browse plants dry up and shed their leaves, *E. crassipes* are available and thus, remain the available green vegetation (Mako and Babayemi, 2008). The dearth of dietary animal protein with increasing cost of production, coupled with rapid population growth, necessitate the search for non-conventional sources of protein such as leaf protein concentrates (LPC) from water hyacinth (Ogunlade, 1992). The plant in combination with concentrate supplements proved to be a good quality protein source for animal feeding (Omojola et al., 2000). Therefore, the objective of this study is to evaluate the nutritive value of *E. crassipes* and *A. zizanioides* and acceptability by West African Dwarf goats.

## MATERIALS AND METHODS

### Collection of samples

#### *Eichhornia crassipes*

*E. crassipes* was collected from a river in Odogbolu Local Government Area of Ogun State in six locations to coincide with early rain, late rain, early dry and late dry season in May, August, November in 2006 and February, 2007 respectively. The area (40 × 5 m) was identified and demarcated by wire mesh to prevent human intrusion (Babayemi et al., 2006). The harvested samples were separated into three anatomical parts (leaf, stem leaf plus stem) and the roots discarded. Harvesting was carefully effected by uprooting from the water. Part of the harvested samples were separately dried as hay and kept in a well ventilated room within the week of their use. Each anatomical part was thoroughly mixed and sub-sampled for further use.

#### *Acroceras zizanioides*

*A. zizanioides* was harvested from six different locations in three dam sites in Ijebu-Ode metropolis and part of the harvested plant were dried separately as hay and kept till needed.

### Chemical analysis

Representative sub-samples were dried in a forced drought oven at 105 to 110℃ to a constant weight for dry matter determination. Crude protein, crude fibre, ether extract, and total ash were analyzed in triplicates according to AOAC (1990) procedures.

### Quantitative determination of tannin, phenol and saponin

Tannin contents were determined as described by Swain (1979). 0.20 g of sample was measured into a 50 ml beaker, 20 ml of 50% methanol was added and covered with parafilm and placed in a water bath at 77 to 80℃ for 1 h. It was shaking thoroughly to ensure a uniform mixing. The extract was quantitatively filtered using a double layered Whatman No. 41 filter paper into a 100 ml volumetric flask, 20 ml water added, 2.5 ml folin-Denis reagent and 10 ml of 17% $Na_2CO_3$ were added and mixed properly. The mixture was made up to mark with water mixed well and allowed to stand for 20 min. The bluish-green color developed at the end, which ranged between 0 to 10 ppm were treated similarly as 1 ml sample previously carried out. The absorbances of the Tannic acid standard solutions as well as, samples were read after color development on a spectronic 21D spectrophotometer at a wavelength of 760 nm. Percentage tannin was calculated using the formula:

$$\frac{\text{Absorbance of sample} \times \text{gradient factor} \times \text{dilution factor}}{\text{Wt. of sample} \times 10{,}000}$$

Phenol contents were determined as described by A.O.A.C (1984). 0.20 g of sample was weighed into a 50 ml beaker, 20 ml of acetone was added and homogenize properly for 1 h to prevent lumping. The mixture was filtered through a Whatman No.1 filter paper into a 100 ml Volumetric flask using acetone to rinse and made up to mark with distilled water with thorough mixing. 1 ml of the sample extract was pipetted into 50 ml Volumetric flask, 20 ml of water was added, then, 3 ml of phosphomolybdic acid was added followed by the addition of 5 ml of 23% $Na_2CO_3$ and mixed thoroughly, made up to mark with distilled water and allowed to stand for 10 min to develop bluish-green colour. Standard Phenol of concentration ranging between 0 to 10 mg/ml was prepared from 100 mg/l stock Phenol solution from Sigma-Aldrich chemicals, U.S.A. The absorbances of sample as well as, that of standard concentrations of Phenol were read on a Digital Spectrophotometer at a wavelength of 510 nm. The percentage phenol is calculated using the formula:

$$\frac{\text{Absorbance of sample} \times \text{gradient factor} \times \text{dilution factor}}{\text{Wt. of sample} \times 10{,}000}$$

The Spectrophotometric method of Brunner (1984) was used for saponin Analysis. 1 g of finely ground sample was weighed into a 250 ml beaker and 100 ml of isobutyl alcohol was added. The mixture was shaken on a UDY shaker for 5 h to ensure uniform mixing. Thereafter, the mixture was filtered through a Whatman No. 1 filter paper into a 100 ml beaker and 20 ml of 40% saturated solution of Maganesium carbonate was added. The mixture obtained with saturated $MgCO_3$ was again filtered through a Whatman No. 1 filter paper to obtain a clear colorless solution. 1 ml of the colorless solution was pipetted into 50 ml volumetric flask and 2 ml of 5% $Fecl_3$ solution was added and made up to mark with distilled water. It was allowed to stand for 30 min for blood red color to develop. 0 to 10 ppm standard saponin solutions were prepared from saponin stock solution.

The standard solutions were treated similarly with 2 ml of 5% $Fecl_3$ solution as done for 1 ml sample previously carried out. The absorbance of the sample as well as, the standard saponin solutions were read after color development in a Jenway V6300 Spectrophotometer at a wavelength of 380 nm. Percentage saponin was calculated using the formula:

$$\frac{\text{Absorbance of sample} \times \text{gradient factor} \times \text{dilution factor}}{\text{Wt. of sample} \times 10{,}000}$$

### Acceptability

#### *Experimental goats*

Twenty four female West African Dwarf (WAD) goats previously certified fit by the university veterinarian was subjected to free choice feeding to evaluate the acceptability of the two aquatic weeds for different days in a cafeteria feed preference study (Babayemi et al., 2006). The pre-experimental weight and age of the goats used were between 10 to 15 kg and about a year old. They were housed together in a pen within the goat house which was constructed to achieve good ventilation. The floor of the house was made of concrete and covered with wood shavings for easy cleaning of the pen.

#### *Feeding of animals*

Dried and fresh (collected daily) aquatic weeds served to the goat feed were placed in separate feeding troughs in triplicates and were strategically placed in the pen in form of cafeteria feeding (Babayemi et al., 2006). The wooden feeder (150 × 60 cm) was used to enable the twenty four goats feed simultaneously in a convenient situation with each animal having free access to each of the two forms of the aquatic weeds in the feeding troughs. Feeders were changed every day to prevent adaptation of the animal to particular forage form and type. The feeding was allowed from 08: 00 to 16: 00 h daily. The feed consumed was determined by deducting the feed refusal from the quantity offered. The forage preferred was assessed from coefficient of preference (COP) value calculated from the ratio between the intakes of individual forage divided by the average intake of the forage (Karbo et al., 1993; Babayemi et al., 2006). Thus, the plant was concluded to be acceptable provided the COP was greater than unity.

#### *Digestibility and nitrogen balance*

Sixteen WAD female goats, about a year old and weighing 10 to 15 kg was used to determine the digestibility and nitrogen balance of fresh *A. zizanoides* (AZ) with Guinea grass (GG) as basal diet. The goats were certified free from external and internal parasites and were then allotted in 4 replicates into 4 dietary treatments I (100% GG), II (80% GG + 20% AZ), III (60% GG + 40% AZ) and IV (100% AZ). The goats were confined in individual modified (Akinsoyinu, 1974) metabolism cages for a separate collection of faeces and urine. The goats were fed between 8: 00 and 13: 00 h daily. Accurately, weighed diets were offered and refusals also weighed before the morning feed to determine the actual intake. Fresh water was provided daily. The trial lasted for 14 days as the first seven days were used for adjusting the animals to the cages while the last seven days were used for the collection of faeces and urine in which, the aliquots (10%) of each day collection of faeces for each animal were dried at 105℃ to a constant weight. Wit hout addition of antibacterial, the urine was stored in airtight plastics bottles and kept frozen at -20℃ until needed for analysis.

### Statistical analysis

Data obtained were subjected to analysis of variance (ANOVA) and mean separations where there were significant differences by Duncan multiple range F-test using statistical Analysis System (SAS, 1999) package.

## RESULTS

Table 1 shows the proximate composition of the three anatomical parts of *E. crassipes.* Dry matter, crude protein and ether extract content were higher in the leaves than any part of the plant. The content of ash was similar in the leaves and leaves plus stem. The stem contained more crude fibre and ash than the parts of leaves and stem plus leaves. Presented in Table 2 is the chemical composition of fresh and sun-cured *E. crassipes* (EC) and *A. zizanoides* (AZ)*.* The fresh plant contained more ($p < 0.05$) crude protein and ash than the sun-cured plant, while the sun-cured plant contained more ($P < 0.05$) dry matter, crude fibre and ether extract than the fresh plant. The quantitative analysis of secondary metabolites (Table 3) in the aquatic plants showed that Phenol content (2.31 g/100 g DM) of EC was higher than the value of 1.81 g/100 g DM obtained for AZ, same trend was observed for the content of saponin (1.25 and 0.25 g/100 g DM) for EC and AZ respectively. However, AZ recorded the highest value (1.08 g/100 g DM) of tannin while EC recorded the lowest value (0.86 g/100 g DM). Table 4 revealed the different forms of the forage in which the goats were permitted to have free choice selection and acceptability of the two aquatic weeds by WAD goats. According to -COP, the offered water weeds and their forms were well accepted except for fresh *E. crassipes*. However, a higher preference was shown towards AZ for both forms and less for EC. Proximate composition of the experimental diets (Table 5) showed that crude protein (24.10%) content of AZ was higher than the 7.29 CP of PM hay. The crude fibre was lower in AZ (12.50%) than what was obtained for PM. It was observed that the crude protein increased with a decreasing crude fibre as the level of AZ in the diet increased.

Nutrient digestibility and nitrogen balance data are shown in Table 6. There were variations in dry matter intake (DMI) by the goats on diets 1, 2, 3 and 4 with the values of 400.10, 398.10, 385.52 and 253.19 g/d respectively. The dry matter, crude protein and crude fibre digestibility by the goats were not influenced by the treatments. The values of nitrogen balance increased with increasing level of AZ, but was negative (-4.47) for goats fed AZ diet alone. Same trend was observed for nitrogen retention.

## DISCUSSION

Possibly due to the ecological habitat of EC season did not have any deteriorating effect on its nutrient composition, indicating therefore, its potential to sustain ruminants all year round. On a fresh basis, the average dry matter in EC was compared well with the values reported for EC by Khan et al. (2002) and Mako et al. (2011), but lower than the values reported for aquatic fern (Babayemi et al., 2006) and EC (Sophal et al., 2010). The high moisture content of the plant might be a limiting factor in feeding the plant on a fresh basis, since animals would eat more of the plant materials to enable it get

**Table 1.** Proximate composition (g/100 g DM) of three anatomical parts of *Eichhornia crassipes.*

| Anatomical parts | Sub season | Dry matter | Crude protein | Crude fibre | Ether extract | Ash | NFE |
|---|---|---|---|---|---|---|---|
| Stem | ER | 5.36 | 7.04 | 24.15 | 1.75 | 18.26 | 48.80 |
| | LR | 5.20 | 7.23 | 24.20 | 1.75 | 18.60 | 48.22 |
| | ED | 5.46 | 7.22 | 24.30 | 1.74 | 19.00 | 47.74 |
| | LD | 5.53 | 7.28 | 24.60 | 1.76 | 19.07 | 48.01 |
| Mean | | 5.39 ± 0.16[c] | 7.20 ±0.19[c] | 24.31 ± 0.32[a] | 1.75 ± 0.10[b] | 18.73 ± 0.29[a] | 48.20 ±0.43[c] |
| Leaf | ER | 10.55 | 14.21 | 13.25 | 2.34 | 15.90 | 54.30 |
| | LR | 10.58 | 14.33 | 13.27 | 2.34 | 16.22 | 53.84 |
| | ED | 11.19 | 14.37 | 13.63 | 2.35 | 16.32 | 53.60 |
| | LD | 11.96 | 14.40 | 13.64 | 2.34 | 16.69 | 52.93 |
| Mean | | 11.07 ±0.24[a] | 14.23 ±0.26[a] | 13.46 ±0.25[c] | 2.34 ±0.12[a] | 16.26 ± 0.27[b] | 53.42 ±0.46[a] |
| Leaf + Stem | ER | 7.59 | 14.21 | 21.19 | 1.22 | 16.84 | 49.16 |
| | LR | 7.79 | 14.33 | 21.23 | 1.24 | 16.89 | 49.02 |
| | ED | 7.91 | 14.37 | 21.23 | 1.24 | 16.90 | 48.96 |
| | LD | 8.16 | 14.40 | 21.27 | 1.23 | 16.90 | 49.05 |
| Mean | | 7.86 ± 0.2[b] | 14.23 ± 0.26[a] | 21.23 ± 0.30[b] | 1.23 ±0.08[c] | 16.88 ± 0.28[b] | 49.05 ±0.44[b] |
| SEM | | 1.03 | 2.89 | 3.20 | 0.09 | 2.56 | 1.03 |

[a, b, c] means in the same column with the same superscripts are not significantly different ($p<0.05$), NFE = Nitrogen free extract, ER (Early rain), LR (Late rain), ED (Early dry), LD (Late dry), ± = standard deviation.

**Table 2.** Proximate composition (g/100 g DM) of Fresh and Sun-cured *Eichhornia crassipes* and *Acroceras zizanioides.*

| Aquatic plant | Dry matter | Crude protein | Crude fibre | Ether extract | Ash | NDF |
|---|---|---|---|---|---|---|
| *Eichhornia crassipes* | | | | | | |
| Fresh | 7.70 | 11.80 | 1.56 | 1.56 | 22.91 | 44.51 |
| Sun-cured | 89.30 | 11.62 | 1.27 | 1.27 | 18.24 | 47.57 |
| *Acroceras zizanoides* | | | | | | |
| Fresh | 18.72 | 23.60 | 6.00 | 6.00 | 20.01 | 37.99 |
| Sun-cured | 90.89 | 22.81 | 5.61 | 5.61 | 19.31 | 37.93 |

**Table 3.** Anti-nutritional factors (g/100 g DM) in *Eichhornia crassipes* and *Acroceras zizanoides.*

| Forage | Anti- nutrients | | |
|---|---|---|---|
| | Phenol | Tannin | Saponin |
| *Eichhornia crassipes* | 2.31 | 0.86 | 1.25 |
| *Acroceras zizanioides* | 1.81 | 1.08 | 0.25 |

adequate amount of nutrient for body metabolism. Unfortunately, this might not be attainable since the level of feed intake in ruminant is also controlled by the capacity of the digestive tract, particularly, the rumen, with the animal ceasing to eat when a certain degree of 'fill' has been attained. However, it has been confirmed that the high amount of water in the plant can be reduced by dehydrating the harvested plant materials under the sun as wilted and hay (Mako and Babayemi, 2008).

The sun-cured forms of both aquatic weeds contained

**Table 4.** *Eichhornia crassipes* and *Acroceras zizanioides* acceptability by West African Dwarf goats.

| Aquatic plant | Mean daily intake (kg DM) | Coefficient of preference (COP) |
|---|---|---|
| *Eichhornia crassipes* | | |
| Fresh | 0.91 ± 0.03 | 0.74 |
| Sun-cured | 1.28 ± 0.06 | 1.04 |
| | | |
| *Acroceras zizanoides* | | |
| Fresh | 4.26 ± 0.16 | 2.25 |
| Sun-cured | 2.86 ± 0.12 | 1.36 |

**Table 5.** Proximate composition (g/100g DM) of diets fed to goats.

| Nutrients | 100% PM | 80% PM + 20% AZ | 60% PM+ 40% AZ | 100% AZ |
|---|---|---|---|---|
| Dry matter | 87.32 | 65.30 | 68.00 | 18.87 |
| Crude protein | 7.29 | 11.36 | 15.31 | 24.01 |
| Crude fibre | 46.21 | 38.82 | 33.50 | 12.50 |
| Ether extract | 1.00 | 4.22 | 4.50 | 6.51 |
| Ash | 13.01 | 14.80 | 15.23 | 18.34 |
| Nitrogen free extract | 32.49 | 30.8 | 31.46 | 38.64 |

PM; *Panicum maximum,* AZ; *Acroceras zizanioides.*

**Table 6.** Nutrient digestibility (%) and N-balance values of goats fed *Panicum maximum* (PM) and varying levels of *Acroceras zizanioides* (AZ).

| Nutrients | Diet 1 | Diet 2 | Diet 3 | Diet 4 | SEM |
|---|---|---|---|---|---|
| DM intake g/d | $400.01^{a}$ | $403.10^{a}$ | $402.21^{a}$ | $253.93^{b}$ | 7.35 |
| DM faeces | $143.35^{b}$ | $163.58^{a}$ | $161.31^{a}$ | $101.83^{c}$ | 3.42 |
| DM digestibility % | 48 | 51 | 56 | 38 | 4.2 |
| N- intake g/d | $3.85^{d}$ | $4.05^{c}$ | $6.70^{b}$ | $6.95^{a}$ | 0.12 |
| N-faeces g/d | $0.61^{c}$ | $0.54^{d}$ | $1.07^{b}$ | $6.32^{a}$ | 0.05 |
| N- urine g/d | $0.23^{d}$ | $0.28^{c}$ | $0.32^{b}$ | $3.43^{a}$ | 0.03 |
| N-balance g/d | $3.01^{c}$ | $3.23^{b}$ | $5.31^{a}$ | $-3.10^{d}$ | 0.20 |
| N-retention (%) | $60.85^{c}$ | $76.82^{b}$ | $80.01^{a}$ | $-43.21^{d}$ | 0.52 |

$^{a,b,c,d}$= means on the same column with the same superscripts are not significantly different ($p<0.05$). Diet 1= 100% PM, Diet 2= 80% PM +20% AZ, Diet 3 = 60% PM + 40% AZ, Diet 4 = 100% AZ.

more crude fibre than the fresh plant, probably, because there is an increase in DM as forages generally increase in crude fibre with age (Topps, 1992). The analytical studies of the three anatomical parts of EC showed that the crude protein values were noticeably high in the leaf followed by stem plus leaf. The lowest crude protein content was recorded in the stem and this could be because the stem contained more crude fibre, being that crude fibre is known to be diluents, which decreases crude protein contents in plants. The level of crude protein in EC especially, in the leaves is high enough to meet the protein requirements of small ruminant (NRC, 2001). The reason for high content of crude protein and ash in the fresh plant than the sun-cured plant of the water weeds (EC and AZ) could be attributed to many reasons. During the storage of forages, fermentation may lead to decrease in nutrient content because micro-organisms require some of the nutrients for microbial growth (McDonald et al., 1988) and seepage of nutrients could also be responsible (Mako and Babayemi, 2008). The mean crude fibre of 11.01% in EC obtained in this study was lower than the value of 27.88% obtained for *Nephrolepus biserrata* (Babayemi et al., 2006) and 33.9% obtained for Napier grass (*Pennisetum purpureum*). The reason for the high content of CF in the stem of the aquatic weeds than the leaves and stem plus leaf could be due to the fact that as leaves matures and fall off and are replaced by younger and more photosynthetically active ones, the process of lignifications proceeds in the stem, thereby, increasing the percent of old stem in the entire biomass. The absence of seasonal variation in the ash content of EC suggests a balance of mineral content through the year for animals consuming the aquatic plant.

The two water plants (*E. crassipes* and *A. zizanioides*) used in this study contained the principal anti-nutritional factors found in a number of tropical forages (Fievez et al., 2005). Phenol and saponin contents in EC were higher than those in the AZ, except for tannin. The values obtained in the present study for the two water plants were within the acceptable limit of 5% (tannin) and 4% (saponin) for intake and digestibility in ruminants (Teferedegene, 2000). The presence of tannins and saponin in the EC and AZ was an added advantage because they were found to have beneficial effect in ruminants. Saponin has been identified as an active compound in suppressing methanogenesis (Hess et al., 2003; Babayemi et al., 2004). The low content of saponin is advantageous but high saponin would retard feed intake of ruminants (Onwuka, 1983). Methane is a dietary energy loss and an important green house gas contributing to global warming (Johnson and Johnson, 1995). Tannins have been reported to form complex with protein in the rumen and remain indigestible due to the high pH and invariably dissociates in the abomasums at a lower pH for proper digestion (Barry and McNabb, 1999).

Reason for the high preference for AZ was not clear; nevertheless, it could be linked with its high crude protein content. Small ruminants prefer sweet plants and generally reject bitter plants (Krueger et al., 1974). The crude protein content of AZ was 10 to 15% higher than the conventional forages (Mishral et al., 1987). All goats fed with AZ and PM mixtures and grass alone consumed above 3% of their body weight, which agrees with the value of 3 to 5% of body weight as DMI recommended for ruminants (ARC, 1985). Feeding of PM was replaced at 20 and 40% by AZ and did not have any effect on digestibility values, since digestibility of crude protein, crude fibre and dry matter increased as PM was replaced with AZ, this agrees with the work of Sophal et al. (2010) (feeding yellow cattle with cassava hay and EC).

It was noted that the replacement of AZ with PM enhanced nitrogen balance and nitrogen retention appreciably. However, goats fed with100% AZ showed a strong negative balance and retention, this agrees with the findings of El-Serafy (1979). It could be explained along the following lines. A basic diet of AZ and PM is“good forage” helping to retain the digesta in the rumen and allowing greater ruminal degradation. Certain parts of AZ such as the leaves may have readily degradable cellulose, which is important for the activity of the cellulolytic bacteria (Juul-Nielson, 1981). The strong negative N-balance and N-retention when 100% AZ was fed, suggests a more rapid passage through the rumen without the PM in the diet.

## Conclusion

The results present in this study revealed that *A. zizanoides* and *E. crassipes* are high in nutrients and are well acceptable by goats. The study further revealed that AZ is more acceptable than EC and had no deleterious effect on intake and utilization by goats when fed at varying levels of supplementation along with PM. The result also revealed that water plants are useful in combination with feeds of poorer quality, but animals cannot be sustained on water plants alone.

## REFERENCES


Akinsoyinu AO (1974). Studies on Protein and energy utilization by West African dwarf goats Ph.D, Thesis, University of Ibadan. Nigeria.

AOAC (1984) 14th edition. Pg 187-188. INC IIII, North Nineteenth street, suite 210 Arlington VA, pp. 222-114.

AOAC (1990). Official methods of Analysis, 15th edition. Washington, DC, USA: Assoc. Official Anal. Chem., pp. 69-88

ARC (1985). Agricultural Research Council. The nutrient requirements of farm animals. No 2 Ruminants: Technical Review and Summaries. ARC, London.

Atsu DW (2002). Contributory role of Animal production in National Development Process of the 17th Annual Conference of Animal Science Association of Nigeria. September 16th – 19th 2002. pp. 17-18.

Babayemi OJ, Demeyer KD, Fievez V (2004). Nutritive value and qualitative assessment of secondary compounds in seeds of eight tropical browse, shrub and pulse legumes. Commun. Agric. Appl. Biol. Sci. Ghent University. 69(1): 103-110

Babayemi OJ, Bamikole MA, Omojola AB (2006). Evaluation of the nutritive value and free choice intake of two aquatic weeds (*Nephrolepis biserrata* and *Spirodela polyrhiza*) by West African Dwarf goats. Trop. Subtrop. Agro Ecosyst., 1: 15-22

Babayemi OJ (2007). *In Vitro* Fermentation Characteristics and Acceptability by West African dwarf Goats of some Dry Season Forages. Afr. J. Biotechnol., 6(10): 1260-1265.

Barry TN, McNabb WC (1999). The implication of condensed tannins on the nutrition value of temperature forages fed to ruminant. Br. J. Nutr., 18: 263-272.

Brunner JH (1984). Direct Spectrophotometer determination of Saponin. Anal. Chem. 34: 1314-1326.

EL-Serafy AM, EL-Ashry MA, Allam SM, Swidan FZ, Khatab HM, Soliman HS (1979). Utilization of water hyacinth as silage and hay by ruminants. Department of Animal production University of Ainshams Cairo Egypt.

Erinoso HO, FWACP O Olusanya and Atinmo, T. (1992). Nutrient intakes of children in a rural Nigeria community. J. Trop. Pediatr., 38(6): 329-331

Fievez V, Babayemi OJ, Demeyer D (2005). Estimation of Direct and Indirect Gas production in Syringes: a tool to estimate short chair fatty and production requiring minimal laboratory facilities. Anim. Feed Sci. Technol., 123(124): 197-210

Hess HD, Monslave LM, Lascano CE, Carcilla JE, Diaz TE, Kreuzer M (2003). Supplementation of tropical grass diet with forage legumes and sapindus sponaria fruits; effect on *in vitro* ruminal nitrogen turn over and methanogenesis. Australian.

Johnson KA, Johnson DE (1995). Methane emission in cattle. J. Anim. Sci., 73: 2483-2492.

Juul-Niel J (1981). Nutritional principles and productive capacity of the Danish Strawmix system for ruminants. Paper presented at second annual seminar on maximum livestock production from minimum land Bangladesh Agriculture University, pp. 2-5

Karbo N, Barnes P, Rudat H (1993). An evaluation of browse forage preferences by sheep and goats in the Northern Guinea Savannah zone, Ghana, In Nidkumana and de Leeuw P (eds). Proceedings of the 2nd African Feed Resource Network (AFRNETA) sustainable. Feed product, and utilization for smallholder livestock. Enterprised in Sub-Saharan African Harare, Zimbabwe, pp. 107-115.

Khan MJ, Steingass H, Drochner W (2002). Nutrition evaluation of someaquatic plants for animal feeding. Bangladesh J. Agric. Sci., 29(2): 317-324.

http://www.unihohenheim.de172633.html?typo3state=allpublications &institution=419.
Krueger WC, Laylock WA, Price DA (1974). Relationship of taste, smell and touch to forage selection. J. Range Manag., 27: 258-527.
Mako AA, Babayemi OJ (2008). Nutritional Evaluation of water hyacinth as ruminant feed to curtail its environmental menace in Nigeria. Afr. J. Livest. Ext., 6: 48-53.
Mako AA, Babayemi OJ, Akinsoyinu AO (2011). An evaluation of nutritive value of water hyacinth (*Eichhornia crassipes* Mart. Solms-Laubach) from different water sources as animal feed. Livest. Res. Rural Dev., pp. 23-25.
McDonald P, Edwards RA, Greenhalgh JFD (1988). Animal Nutrition (4$^{th}$ edn). Longman Publisher, pp. 200-250.
Mishral RM, Panda NC, Sahu BK, Rao AC (1987). High potassium as incriminating factors in water hyacinth. Indian J. Anim. Sci., 57: 991-999
NRC (2001). Nutrient requirements for dairy cattle seventh revised edition. National Research Council. National Academy of Science press. Washington DC, USA.
Ogunlade Y (1992). Chemical and Nutritional evaluation of Water Hyacinth in Nigeria water ways. Ph. D Thesis Obafemi Awolowo University, Ile-Ife.
Oguntona CRB, Akinyele IO (2002). Food and nutrient intakes by pregnant Nigerian adolescents during the 3rd trimester. Intern. J. Appl. Basic Nutr. Sci., 18(7): 673-679
Omojola AB, Adewumi MK, Olomola A, Adesehinwa AOK (2000). Feed Utilization by West African dwarf goats fed graded levels of aquatic fern (*Nephrolepis biserrata* schott) – Based diets. Trop. Anim. Prod. Invest., 4: 55-62.
Onwuka CFI (1983). Nutritional Evaluation of some Nigerian browse plants in the humid tropics. Ph. D Thesis, University of Ibadan.
SAS (1999). Statistical Analytical System, SAS/ STAT User's guide, SAS institute Inc., Cary, North Carolina USA.
Sophal C, Borin K, Preston TR (2010) Effect of supplementation of water hyacinth and cassava hay on the performance of local "Yellow" cattle fed a basal diet of rice straw. Livest. Res. Rural Dev. pp. 22-29.
Swain T (1979). Tannins and Lignins. In: Rosenthal GA and Janzen DH (eds). Herbivores: their interaction with plant metabolites. Academic press. New York.
Teferedegne B (2000). New perspectives on the use of tropical plants to improve ruminant nutrition. Proc. Nutr. Soc., 59: 209-214.
Topps JH (1992). Potential Composition and use of Legume Shrubs and trees as fodder for livestock in the tropics. J. Agric. Sci., 118: 1-8.